

UNIVERSITY OF TORONTO
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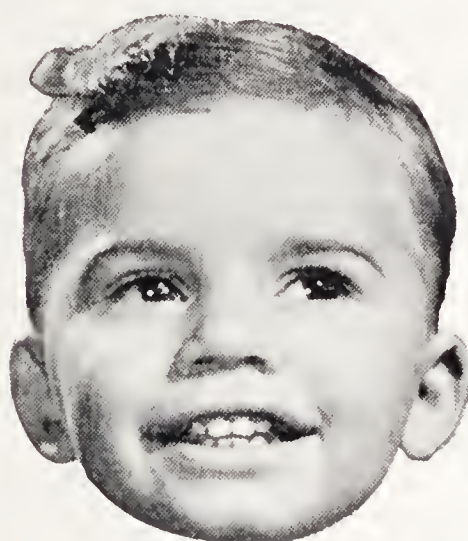
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EDITORIALS

THIS ISSUE

This issue, on the Urinary System, is the last of a series of three on the main organ systems. The next three issues in this volume will deal with other aspects of disease. In this issue we have dealt with some of the more general problems associated with dysfunction of the kidneys, ureters and bladder. Though much exists in textbooks on this subject, we have tried to point up some things which present special difficulties for students.

In these, as in many other articles in this journal, treatment has been relegated to a more minor position. While treatment is very important in medicine and *the* most important thing in the *practice* of medicine, we feel that the main aim of these discussions should be to promote understanding of the things which can happen. From this, treatment in most cases follows logically. Where the treatment is sufficiently unusual to justify comment, we have done so, but in other places, only a comment is required.

THE MEDICAL AT HOME

As everyone should know by now, the Medical At Home is being held in the Royal York Hotel on Thursday, February 14, (Valentine's Day). This is no ordinary dance, but an affair which warrants your support, not merely out of loyalty, but also because you will probably have a very good time. There will be two good orchestras, Benny Louis and Bobby Gimby, professional entertainment, and a sketch artist who will do your girl's (or even your) portrait—and it's all on the house. But such incentives as these are only added attractions. It is the meeting of friends under slightly different conditions than those of the lecture theatre which is important, and the support you can give for one of the few all-Medical functions of the years. And besides, as we said before, you are almost sure to have a wonderful time.

ACKNOWLEDGEMENT

We wish to thank Dr. P. O. Crassweiler for his guidance and constructive criticism in the preparation of this issue of the journal.

DEFINITION

THE term uremia literally means excess of urea in the blood. But to-day it is used to indicate the clinical picture seen when excretion of body waste products and conservation of needed material by the kidney fails. The syndrome, due not so much to retention of urea as to other complex biochemical changes that occur as well, can be resultant upon various states, and these will be mentioned when pathology is discussed. Such changes include disturbances in acid-base equilibrium and in salt-water balance.

PATHOLOGY

The pathology of uremia or kidney failure may occur as a result of mechanisms operating at any of three levels. That is, the etiology may be *prerenal*, in which ease kidney function is disrupted by reduction of renal blood supply, or it may be *renal*, where failure is due to parenchymal kidney disease, or finally, *post-renal*, in which ease obstruction to outflow of urine is the cause of renal failure.

Prerenal

Reduction of blood supply to the kidneys may follow the advent of shock. Shock may be due to such events as blood loss from trauma or gastrointestinal bleeding, loss of plasma from burns or crush injuries, or loss of fluid through vomiting, diarrhea, excessive urine excretion as in diabetes, or from skin as excessive sweating in heat stroke. In some cases the circulatory upset may be severe enough and last long enough to produce damage to the renal parenchyma, and a condition known as acute tubular necrosis ensues.

Information about acute tubular necrosis has been gathered from studies of crush injuries during wartime, in which large muscle masses were crushed by heavy objects during air raids; the result was ischemic necrosis, swelling and loss of fluid into the limb or limbs involved, to be followed by anuria and the uremic syndrome.

The pathogenesis of this condition is probably as follows: severe shock and dehydration are accompanied by generalized vasoconstriction, including the afferent glomerular arterioles. This, together with the hypotension, produces renal ischemia which if severe and prolonged causes a spotty necrosis of renal tubules. The necrosis can occur anywhere along the tubules, but especially in the lower nephron including the basement membrane. The associated anuria may be due to increased permeability of damaged tubules, resulting in back diffusion of total filtrate into the blood stream or loss of glomerular filtrate through actual holes in the tubular wall. Edema of the kidney may also contribute toward anuria by reducing glomerular filtration.

The picture of acute tubular necrosis can also be seen after mercury poisoning, incompatible blood transfusion or following sulphonamide administration, but in these cases necrosis of the proximal tubule only occurs, and the basement membrane is not destroyed, thus allowing for complete regeneration.

Renal

The pathology of renal uremia is that which is seen in diseases affecting the renal parenchyma primarily. This includes well known conditions such as glomerulonephritis, chronic bilateral

pyelonephritis, polycystic disease of the kidneys and nephrosclerosis.

Briefly the pathology of glomerulonephritis is one in which the earliest lesion is a diffuse inflammation of glomerular capillaries with swelling and proliferation of endothelium and accumulation of inflammatory products in the tuft and glomerular space. Progressive cases will then show a proliferation of the epithelium of Bowman's capsule and formation of epithelial crescents. Progressive fibrosis occurs with gradual obstruction of glomerular capillaries, and a consequent secondary degeneration of tubules. Fibrous tissue may eventually replace many nephrons. It can be seen from this picture that renal efficiency may eventually become greatly disturbed through impaired glomerular filtration primarily and probably through tubular dysfunction secondarily.

The pathological picture of chronic pyelonephritis wanders not very far from that seen in chronic glomerulonephritis or nephrosclerosis. The fully developed case shows gross scarring of the kidneys which may be reduced in size with narrow cortices. Under the microscope the interstitial tissue shows inflammation, and there is fibrosis around the glomeruli. Tubules may be atrophic with pus and casts in the lumina, and the pelves are infiltrated with chronic inflammatory cells. Arteries and arterioles are narrowed and sclerosed. Here, again, as in chronic glomerulonephritis and nephrosclerosis, renal failure is consequent upon glomerular and tubular damage.

In advanced nephrosclerosis the picture is not too different. There is sclerosis or obliteration of renal arterioles, patchy fibrosis of parenchyma, tubular destruction, and obliteration of glomerular tufts. The end results are contracted scarred kidneys of little functional capacity.

In polycystic disease the kidneys are

much larger than normal, and consist of masses of cysts with a varying amount of parenchyma showing fibrosis and arteriosclerosis.

Post-Renal

Obstruction to urine flow may occur at any point along the urinary tract. Some of the possible causes are ureteral calculi, accidental ligation at operation, and congenital anomalies. In uremia due to obstruction above the level of the bladder, the block to urine outflow will be bilateral. In patients where the obstruction is distal to the bladder, the latter may show progressive enlargement and hypertrophy, diverticulum, and calculus formation. There may be dilatation of the ureter (hydroureter) and pelvis and calyces (hydronephrosis) which results from the increasing pressure above the point of obstruction. Atrophy of kidney parenchyma will occur if the obstruction is not relieved, and infection will eventually supervene as a cystitis and pyelonephritis.

In hydronephrosis the increased pressure in the urinary tract above the obstruction is reflected as an increased intratubular hydrostatic pressure. If many tubules are dilated, the renal interstitial pressure will also rise. The combined raising of both intratubular and interstitial pressure will oppose glomerular filtration which will consequently be reduced. A high interstitial pressure will also interfere with the blood supply to the tubules resulting in impaired tubular function as well.

METABOLIC CONSIDERATIONS

Renal insufficiency, the clinical manifestation of which is the uremic syndrome, results when the kidneys can no longer maintain a constant environment for the cells of the body. The term covers a wide range of electrolyte disturbance and one cannot use it without modification and still expect to be specific. For

example, renal insufficiency in distal tubular disease may result in an acidosis with hyperchloremia and a normal blood NPN, whereas renal insufficiency due to impaired glomerular filtration may result in normal blood chloride levels with an acidosis accompanied by high serum phosphate and sulphate levels.

In far advanced pyelonephritis, glomerulonephritis, hydronephrosis, and nephrosclerosis the extracellular electrolyte pictures tend to be similar. Inorganic phosphate, sulphate and potassium are increased in the blood, while calcium and bicarbonate are depressed. This produces a lowering of the carbon dioxide combining power, or in other words, the condition of acidosis ensues. Sodium and chloride (and sometimes potassium) levels vary with extrarenal factors such as vomiting and diarrhea.

Impaired glomerular filtration seems to be a major mechanism in the production of electrolyte abnormalities in extensive renal deterioration. The catabolic products of carbohydrate, protein and fat destined for excretion are carbon dioxide, water, non-protein nitrogen, sulphate and phosphate, potassium and magnesium. If the ureters were tied, one would observe accumulation in the blood of phosphate, sulphate, potassium, magnesium and non-protein nitrogen, all of which are excreted primarily by the kidneys.

Other important factors are failure of ammonia production and phosphate buffer mechanism provided by healthy nephrons; sparing of base declines as a result with consequent loss of base (sodium mainly) in the urine, and aggravation of the acidosis.

Renal insufficiency may be due to temporary or permanent renal damage. An example of renal insufficiency without permanent damage is prostatic hypertrophy with chronic urinary retention. Here glomerular filtration primarily

is impaired resulting in retention of nitrogenous constituents in the blood, organic and inorganic acids. As a result, the carbon dioxide combining power is reduced, and the patient will show signs and complain of symptoms indicating abnormal cellular function due to disturbed body cellular environment.

The permanently damaged kidney may be able to maintain homeostasis (constant body cellular environment) and prevent renal insufficiency as long as twenty percent or more of normal total function is still retained. If a larger portion of nephrons is involved, renal insufficiency will become apparent so that failure of the kidneys to maintain homeostasis is a terminal affair. Occasionally a patient is seen with kidney function that is borderline, i.e., homeostasis is maintained under non-stressful conditions, but if stress occurs, as in surgery or generalized infection, the number of functioning nephrons may not be equal to the added load, and renal insufficiency becomes manifest.

There has been some suggestion that the blood phenol level is the specific factor responsible for much of the uremic syndrome, but this has not been proven. Certainly the elevated abnormal level of blood nitrogen is not the sole factor responsible for the clinical picture. Some of the suggested relations between symptoms and signs and abnormal chemistry are given below.

CLINICAL ASPECTS

1. *Gastrointestinal*

Anorexia, nausea and vomiting are early symptoms, often intractable and the cause of much of the patient's discomfort. Possible causes are increased intracranial pressure, gastrointestinal irritation by ammonia formed through bacterial action on the large amount of urea in the gut, retention of potassium and guanidine, and toxic effects of drugs

given that would normally be excreted by functioning kidneys.

The intestines may be the site of purpuric ecchymoses, and hemorrhage from stomach or rectum may occur.

2. Nervous System

Signs and symptoms of both irritation and depression of the nervous system occur, and these may be severe. Muscular twitching or convulsions are seen; the patient may be drowsy or sleepy progressing to confusion, stupor and coma terminally. The signs of irritation (twitching, convulsions) are probably due to a decrease in calcium ions in the blood; drowsiness or coma to dehydration and retention of catabolic products. Either irritation or depression may be the main feature depending on which of the chemical factors predominate.

3. Respiratory System

The uremic patient may show one of several types of respiratory disturbances. In frank acidosis there may be breathing of the Kussmaul type (deep, sighing respirations with a rate perhaps only slightly above normal). Older uremies often show periodic Cheyne-Stokes breathing, presumably due to depression of the respiratory centre by the toxic biochemical state and poor cerebral blood supply. Slow stertorous breathing may be the feature where there is increased intracranial pressure. If there is concomitant heart failure, breathing is panting, rapid and laboured.

In connection with any of the above, the uremic breath may be detected, characterized by a fairly typical, sickly, sweet odour.

4. Circulatory System

Uremia may be complicated by congestive heart failure secondary to kidney failure or hypertension. Other circulatory disturbances often seen are hypertension, present in a great majority of cases; vascular retinal changes accompanying

eases with hypertension and generally paralleling the amount of renal vascular damage; pericarditis, usually painless but occasionally accompanied by pain, of unknown mechanism; cardiac arrhythmias and ECG changes probably due to the changes in calcium-sodium or potassium-sodium ratios.

5. Skin

The skin may show brownish or *café au lait* discoloration especially on the face and hands. The discoloration is probably caused by the oxidation of urochromogen pigment in parts exposed to light. Urea "frost", or flaky urea deposits, is occasionally seen, and purpuric areas and other eruptions of unknown cause are frequent.

TREATMENT

The treatment of uremia is complex; here the basic principles of therapy will be set down rather than complicate the issue with specific orders.

1. Renal Uremia

The treatment of chronic nephritis will be described here as an example of the type of therapeutic attack made in cases of renal uremia. Although the eventual fatal outcome of the disease cannot be altered, the patient's health may be considerably enhanced with suitable treatment.

Diet should be of low protein type to reduce protein catabolism to a minimum and prevent aggravation of the excessive nitrogen accumulation in the blood. No more than 40 Gm. of protein a day should be given; fat and carbohydrate should be given in amounts ensuring adequate caloric intake.

In renal uremia not complicated by congestive heart failure, fluid restriction is contraindicated. In view of the impaired renal concentrating power, a larger urine volume is required to excrete nitrogenous and other waste products.

Fluid intake should be sufficient to ensure at least 2500 c.c. of urine daily.

In cases not accompanied by congestive heart failure, edema or arterial hypertension, there is no indication for salt restriction. Indeed, in some cases there will be excessive loss of salt in the urine because of tubular failure to reabsorb sodium, and this will be aggravated by a high fluid intake. Addition of 5–10 Gm. of salt to the diet will often result in clinical improvement in such cases. Close watch, however, must be kept for the onset of pulmonary edema or aggravation of hypertension in which case the salt intake must be cut down.

If calcium loss becomes manifest (for example, muscular twitching), calcium gluconate may be given to the patient orally or intravenously.

The appearance of severe acidosis can be treated by intravenous infusion of one-sixth molar sodium lactate or other base preparation. The volume given will depend on the degree of acidosis and the severity of salt depletion, but on the average about 3–5 litres will be given in 24 hours until signs and symptoms of acidosis have subsided.

Obvious foci of streptococcal infection should of course be removed to reduce the likelihood of an exacerbation of acute nephritis. In cases of chronic pyelonephritis, treatment should also be directed against the renal infection.

2. *Prerenal Uremia*

Cases of prerenal uremia should be treated by oral fluid or appropriate intravenous infusion to compensate for loss of blood, plasma or fluid. In addition specific treatment for the possible disease causing loss of fluid will be required, for example diabetes mellitus or Addison's disease. Treatment of peripheral circulatory failure should be effected quickly and continued until pulse rate and blood pressure have

returned to normal. If oliguria or anuria persist in spite of the return of the blood pressure to normal, one must assume that acute tubular necrosis has occurred and treatment instituted accordingly.

Of first importance in the treatment of acute tubular necrosis is the quick repair of the causal defect in order to prevent or minimize the renal lesions by administration of blood, plasma, glucose-saline or oral fluids. Associated conditions such as infection or anemia must also be treated. In cases of heavy metal poisoning BAL injection is indicated.

Oliguria or anuria is treated by maintaining the water balance. Water loss via the lungs and skin in our climate approximates one litre daily. Thus water intake is restricted to one litre plus the amount of the previous day's output.

A diet adequate in calories and consisting essentially of carbohydrate and fat should be given. This will cut protein metabolism to a minimum and the onset of uremia is delayed.

Maintenance of electrolyte balance is important. The diet should be potassium-free to minimize the accumulation of potassium in the blood. Employment may also be made of cation exchange resins to remove excess potassium from the body. Loss of chloride and sodium through vomiting may be reduced by replacing the fluid lost volume for volume with normal saline.

Feeding will probably be through a gastric tube at first. But when the diuresis accompanying the recovery of the kidneys starts, gastric feeding may be stopped and a light diet containing no more than 40 Gm. of protein given. Fluid intake must be sufficient to replace the fluid lost through the recovering kidneys. During this phase the salt lost in the polyuria must be replenished by administering about 3 Gm. of salt for each litre of urine, and the potassium

loss compensated by adding fruit to the diet. As kidney function becomes normal, a more normal diet can be given.

3. *Post-Renal Uremia*

Surgical treatment is required for all cases of renal failure due to obstruction. The removal of the obstruction followed by a high fluid intake often results in adequate recovery of renal function even in cases of severe post-renal uremia. This is, of course, provided that relief of the obstruction has not been delayed too long.

Finally, mention should be made of a number of techniques devised for the artificial removal of metabolites or toxic substances in cases of renal failure. These can be used as an adjunct to good conservative measures in the treatment of acute renal failure and of exacerbations of chronic renal disease.

Of these, intestinal lavage is probably the most practicable measure; magnesium sulphate or other fluids available for the purpose may be employed. Also available in some centres are the so-called artificial kidneys which are really dialyzers whose operation depends on diffusion of substances from the blood through a semi-permeable membrane. Another method makes use of peritoneal irrigation, helpful in the correction of electrolyte disturbances, but less so in the elimination of unwanted metabolites.

BIBLIOGRAPHY

1. Nesbit and Baum: *Fundamentals of Urology*, 4th Edition.
2. Campbell: *Urology*.
3. Harrison: *Principles of Internal Medicine*, 2nd Edition.
4. Davidson, L. S. P.: *Principles and Practice of Medicine*, 2nd Edition.

NEOPLASMS OF THE KIDNEY

G. I. URBACH, B.A. 5T8

CLINICALLY important renal neoplasms constitute an uncommon group of tumors. The malignant varieties are uniformly associated with a poor prognosis and a high mortality. This is almost entirely due to the late clinical diagnosis of malignant renal neoplasms, and consequently they are not subject to early surgical removal.

The tumors of clinical importance are the malignant renal neoplasms and the benign renal pelvic papilloma. The remainder of the benign renal neoplasms rarely produce clinical symptoms or signs, and are usually present as incidental necropsy findings.

This presentation will be concerned with the pathology, clinical manifestations, diagnosis, treatment and prognosis

of the clinically important renal neoplasms.

CLASSIFICATION

Neoplasms of Adults

Benign A. Renal parenchyma

- i. Adenoma.
- ii. Hamartoma.
- iii. Hemangioma.
- iv. Fibroma.
- v. Leiomyoma.
- vi. Lipoma.

B. Renal pelvis

- i. Papilloma.

Malignant A. Renal parenchyma

- i. Carcinoma—Hypernephroma.
—Adenocarcinoma.
- ii. Sarcoma.
- iii. Wilms' Tumor (rare).

B. Renal pelvis

- i. Papillary carcinoma.
- ii. Squamous cell carcinoma.

Neoplasms of Children

Malignant A. Renal parenchyma

- i. Wilms' Tumor.

NEOPLASMS OF ADULTS

A. Pathology

Hypernephroma (Grawitz Tumor)

Hypernephroma is the most common malignant tumor of the kidney. Its peak incidence is in the sixth and seventh decades.

The tumor forms a large rounded mass in the kidney which is initially discreet and separated from the normal renal parenchyma by a pseudocapsule. However, even at this stage the tumor is microscopically invasive.

The cut surface reveals necrotic and hemorrhagic areas as well as degenerative cyst formation. The tumor is yellow in the gross and irregularly permeated with gray connective tissue trabecular strands.

The microscopic picture is variable, but the characteristic cells are large, pale, and contain a foamy cytoplasm. In scattered areas smaller, denser and more granular cells with eosinophilic cytoplasm may be seen. The cells are arranged in cords or tubular structures with very little supporting stroma.

As the tumor grows larger, the adjacent renal tissue is compressed, becomes atrophic, and is overgrown with connective tissue. In later stages there is extensive invasion of the renal parenchyma and vascular channels. Metastases are thus borne by the blood to the lungs and bones. The regional lymph nodes are commonly invaded by the tumor cells, and must, therefore, always be removed at operation.

These tumors tend to attain a large size before they are detected.

Adenocarcinoma

Adenocarcinoma is a highly malignant tumor which reaches a considerable size.

Microscopically, gland-like structures and irregular cords of cells are present. These cells exhibit pleomorphism and hyperchromatism, and direct invasion into the adjacent renal tissue is common. This tumor is considered by many to be a variety of hypernephroma.

Sarcoma

Sarcomas may arise from the connective tissue of the kidney, but they are rare. Examples of fibrosarcoma and liposarcoma have been reported.

Renal Pelvic Papilloma and Papillary Carcinoma

The renal pelvic papilloma almost invariably proceeds to papillary carcinoma, and surgically both tumors are treated in the same way.

These tumors which are often multiple appear as small projecting papillae in the renal pelvis. They may be confined to a limited area or scattered throughout the renal pelvis. The benign papilloma and the malignant papillary carcinoma have a tendency to ulcerate and bleed because of their extensive vascularity.

Microscopically the benign papilloma appears as a branching villus with minute vascular channels. The villi are covered with a transitional-type epithelium. The tumor cells are cuboidal, dark-staining, and pleomorphic. This microscopic picture is further complicated by round cell infiltration of the stroma.

The papillary carcinoma exhibits a similar microscopic appearance with the addition of infiltration and invasion of the submucosa and connective tissue. In more than 50% of papillary carcinomas there are metastases to the ureter by direct seeding of the malignant cells. Metastases are also commonly found in the lungs and bones.

Renal Pelvic Squamous Cell Carcinoma

These rare, highly malignant, rapidly fatal tumors are often associated with renal calculi which are believed to play a part in the etiology of these neoplasms. Chronic infection and leukoplakia have also been considered in the etiology of squamous cell carcinoma.

Grossly the tumor is a gray tissue mass extending over a portion of the mucosa. The invaded area exhibits marked induration.

Microscopically scattered areas of squamous cells and numerous foci of pearl formation are evident.

Due to its rapid growth this tumor readily invades the normal renal parenchyma and the perirenal structures.

B. Clinical Manifestations

Renal neoplasms may manifest themselves in the form of hematuria, palpable masses, pain, and rarely as unexplained fever.

In the majority of these tumors, the earliest and most important indication of their presence is hematuria. The bleeding may be "silent", coming on suddenly and without any accompanying symptoms, and it will often cease as abruptly as it began.

Pain, which is usually indicative of a fairly advanced neoplastic growth, often follows the distribution of the lumbosacral nerve root. In advanced tumors the pain radiates into the thigh and buttocks.

Renal colic may be manifested when clotted blood passes through the ureter. This colicky pain radiates from the flank into the inguinal region.

Local pain of a dull character may occur due to the involvement and stretching of the renal capsule by an expanding tumor.

Not infrequently, hypernephroma may present itself solely as an unexplained fever.

Palpable masses, like pain, are late signs of a malignant renal neoplasm, and usually are suggestive of an unfavourable prognosis.

Numerous signs and symptoms related to the presence of metastases may be the initial complaint of the patient. The organ or tissue involved and the degree of its involvement will determine the exact nature of the sign or symptom.

C. Diagnosis

Any patient presenting with hematuria in the absence of leucocytes or bacteria in the urine must be investigated for the presence of a malignant renal neoplasm. Similar suspicions may arise in those patients who present with pain and/or masses in the region of the kidney. These patients should undergo a complete urological investigation.

The urological investigation begins with a laboratory examination of a second-glass (mid-stream) voided urine specimen in a male and a catheter specimen in a female. The presence of blood either grossly or microscopically and the presence or absence of bacteria are the most significant findings.

A complete physical examination including a pelvic examination in a female and an external genital examination in a male is an essential part of the investigation. Special care must be taken in the abdominal palpation to detect any renal masses which may be present. Normally only the lower pole of the right kidney is palpable, and this only with deep inspiration in thin individuals.

A cystoscopic examination is used to determine the source of any bleeding. The cystoscope is passed into the bladder, and both ureteral orifices are carefully inspected. A clear spurt of urine will be seen emanating from the normal kidney whereas a spurt of blood will be seen escaping from the ureteral orifice of the affected kidney. This localization of the site of the pathology will attach greater

significance to minor abnormalities in the pyelogram.

Ureteral catheters may then be passed on each side and specimens obtained for microscopic and bacterial examination.

The most important phase of the urological examination, and probably the only true diagnostic procedure short of laparotomy, is a pyelogram. The usual procedure is an intravenous pyclogram which will show up most of the renal tumors. A retrograde pyelogram is often superior in outlining minor filling defects. Intrarenal neoplasms distort the renal calyces and the renal pelvis in a variety of ways; renal pelvic tumors produce filling defects and at times a dilated renal pelvis.

Before any operative procedures are undertaken, renal function tests must be performed to ensure that the kidney which will be left intact is functioning normally.

D. Treatment and Prognosis

Surgical removal of the affected kidney is the only effective form of treatment. The surgical approach is by a thoracoabdominal or transperitoneal incision. In these surgical procedures the renal pedicle must be defined and ligated before any manipulation is started. This will tend to diminish the dissemination of the tumor. All adjacent fatty tissue and lymph nodes must be removed.

In renal pelvic tumors the ureter and portion of the bladder adjacent to the ureteral orifice must also be removed at the time of nephrectomy.

Radiotherapy is of questionable value in renal neoplasms.

The prognosis varies with the type of tumor. The best results have been obtained with papillary carcinoma (30-35% five year survival rate) following radical nephrectomy and removal of the ureter and part of the bladder. Squamous cell carcinomas of the renal pelvis on the

other hand have no recorded five year survivals following operation.

NEOPLASMS OF CHILDREN

A. Pathology

Wilms' Tumor (Embryonal Adenosarcoma)

Wilms' Tumor is a rare neoplasm which occurs almost exclusively in children. Most (75%) of these tumors occur before the age of 5 years, and they constitute 20% of all malignancies of childhood. It is believed to originate from embryonic mesodermal cells which retain their ability to grow and to differentiate into a variety of tissues.

Grossly the tumor is surrounded initially by a connective tissue capsule which separates the tumor from the adjacent renal parenchyma. In later stages the capsule and renal parenchyma are invaded by the malignant cells.

The cut surface appears as a gray uniform mass which may be cystic in various areas.

Microscopically the outstanding characteristic is the abundance of embryonic-like malignant connective tissue surrounding zones of pleomorphic glandular and tubular elements. Cords and strands of epithelial cells may also be dispersed throughout the tumor. Many other types of tissue may be present, and these include smooth muscle, striated muscle and cartilage.

These tumors may invade the renal pelvis, ureter and renal veins. Metastases to regional lymph nodes and lungs are common.

B. Clinical Manifestations

Wilms' Tumor usually presents as a large abdominal mass which is often detected by the mother during the bathing of the infant. Hematuria is usually absent, but fever and leucocytosis may be present if there is necrosis and hemorrhage within the tumor.

C. Diagnosis

On physical examination a large firm non-tender mass is present in the abdomen, and may extend across the midline and down into the iliac fossa. A pyelogram will show distortion of the renal pelvis in the involved kidney, and will also indicate whether or not the other kidney is free from pathological involvement. The final conclusive diagnostic procedure is laparotomy.

D. Treatment and Prognosis

Before surgical treatment is undertaken, roentgenograms of the chest are taken to exclude lung metastases.

The treatment of choice is nephrectomy through a transabdominal incision. The veins and ureter are ligated prior to manipulation of the tumor.

Since the malignant cells of Wilms' Tumor are very radiosensitive, nephrectomy is followed by postoperative irradiation.

The prognosis is grave, but not as hopeless as was once believed. Apparent cures as high as 47% have been reported in one series of cases. Any recurrence of this malignant tumor will be evident within two years after nephrectomy.

SUMMARY

The renal neoplasms of clinical significance have been discussed with respect to pathology, clinical manifestations, diagnosis, treatment and prognosis.

It has been shown that while these tumors are in general no more malignant than malignant neoplasms of other organs, the poor prognosis is chiefly the result of late clinical detection.

BIBLIOGRAPHY

1. Anderson: Pathology, 2nd Edition.
2. Boyd: Textbook of Pathology, 6th Edition.
3. Davis: Christopher's Textbook of Surgery, 6th Edition.
4. Moseley: Textbook of Surgery, 2nd Edition.
5. Nelson: Textbook of Pediatrics, 6th Edition.

RENAL CALCULI

R. E. MACDONALD, B.A., 5T8

THE formation of stones in the urinary tract produces one of the major problems in urology. Unless passed spontaneously, dissolved, or removed surgically, the frequent complications of urinary obstruction with subsequent urine retention, infection, hemorrhagic ulceration, and even penetration into the abdominal cavity produce grave symptoms and eventually irreparable kidney destruction. Procrastination on the part of the patient with stones not too troublesome, delay due to unawareness of asymptomatic stones, errors in diagnosis, and mismanagement after discovery account for the fact that one-third of all patients with renal calculi lose a kidney from either destruction or nephrectomy.

Before considering the etiology of renal calculi, one should be acquainted with the composition and relative frequency of occurrence of the different types of calculi. In general a calculus consists of a nucleus of organic material around which urinary salts are deposited in concentric layers bound together by a colloidal matrix of organic matter. The salts, although crystalline in the urine, are in the form of amorphous granules in the calculus. Calcium oxalate calculi are the most common, accounting for 60% of the total, followed by calcium and ammonio-magnesium phosphate or pure phosphate—30%, uric acid—4%, urates—4%, cystine—2%, and sulphapyridine stones with the widespread use of sulphonamides—a very small percentage.

ETIOLOGY

There are many known factors concerned with the formation of renal calculi. However, in the great majority of cases, it seems impossible to identify the exact cause of any individual calculus. It is probable that most instances of renal stone formation are dependent upon the interaction and synergism of many factors.

Non-Specific Factors

a. Age

The maximal incidence of this disease to-day occurs at the beginning of the fifth decade. There has been a steady rise in the age incidence in the past fifty years; perhaps it reflects a rising standard of indulgence in essential foods among children and young adults.

b. Sex

The male is invariably more prone to urinary lithiasis than the female in the ratio of 2:1. A more detailed investigation shows that this relative sex incidence varies according to the part of the urinary tract involved. The male predominance increases as the lesion moves from the upper to the lower urinary tract, and is probably explained by the anatomical variation in the bladder neck in the two sexes. The circumferential relationship of the male prostate to the bladder outlet increases the tendency for vesical outlet obstruction.

c. Heredity

There are many instances quoted in the literature in which several generations of the same family have been affected. There are also interesting examples in which brothers and sisters widely scattered in different countries have developed calculi.

d. Race and Geographical Distribution

The white and yellow races are relatively susceptible to urinary stone for-

mation while the negro race is relatively immune. This may be related to the fact that the darkly pigmented negro when exposed to the sun is spared of D hyper-vitaminosis and consequently of increased calcium absorption and elevated calcium excretion.

e. Dehydration

This appears to be of some significance in the development of renal calculi, and the summer months present a higher incidence of renal colic than the winter months. World War II troops engaged in desert fighting showed a higher incidence of renal colic than other troops.

Mechanical Factors

Calculus formation is dependent upon the precipitation of urinary salts or crystalloids such as calcium, phosphorus, potassium, urea, creatinine, cystine and sulphonamides. These crystalloids are normally present in the urine in a supersaturated state, but they remain in solution if enough colloid matrix is also present in the urine. Crystalloid precipitation may appear if the ratio between colloids and crystalloids becomes too abnormal. This ratio may be affected by:

a. Disturbance in colloid balance

Hypoproteinemia resulting from starvation or prolonged ingestion of a low protein diet will result in crystalloid precipitation. The colloids themselves may be precipitated in prolonged fever states, and may lead to the formation of the nucleus of a future calculus.

b. Sparing action of urinary electrolytes

The solubility of a moderately soluble electrolyte is increased by the presence of a more soluble electrolyte. For example, uric acid solubility is increased by the presence of sodium phosphate.

c. Presence of certain non-electrolytes

The solubility of the electrolyte cal-

cium oxalate in urine is doubled by adding urea.

d. *Changes in urine pH*

Calcium phosphate tends to precipitate out in a urine with a pH greater than 7.0 while uric acid and cystine tend to precipitate out at a pH less than 7.0. Oxalates will precipitate out in both acid and alkaline urine. In the absence of metabolic disturbances resulting in an increased production of urinary crystalloids, the pH is important primarily in the precipitation of calcium phosphate and eventually the formation of calcium phosphate calculi. Pyogenic infections of the urinary tract (*B. Proteus*, *Staphylococci*, *Streptococci*) cause an alkaline urine due to their urea-splitting power with resultant precipitation of phosphates. These phosphates may develop into calculi, may coat pre-existing calculi, or may be voided in the form of phosphaturia. Subsequent infection with the colon bacillus may bring back an acid reaction with the deposition of uric acid or calcium oxalate, and in this way a stone is built up.

e. *Congenital abnormalities*

Aberrant renal vessels at the ureteropelvic junction and stricture promote obstruction and infection due to stasis with a resultant pH change and a likelihood of crystalloid precipitation.

Metabolic Factors

a. *Acidosis*

In renal diseases characterized by chronic acidosis and tubular insufficiency such as chronic pyelonephritis and chronic glomerulonephritis, the tubular mechanism for the conservation of base (NH_4^+ and H^+ exchange) does not function normally. Consequently, calcium is mobilized in excess to provide available base for the neutralization of acids and a hypercalciuria develops.

b. *Immobilization*

The stimulus for laying down bone in immobilized patients is decreased and the constant bone reabsorption is not counterbalanced. As a result the urinary excretion of calcium is elevated. The immobilized bed patient has his urinary pelvis at the lowest level in the urinary tract, and there is a natural tendency to stagnation in this part.

c. *Hyperparathyroidism*

Adenoma, carcinoma and hypertrophy lead to hypercalciuria as well as hyperphosphaturia. These conditions produce an increased excretion of the parathyroid hormone which causes an increased excretion of phosphorus, a decrease in the serum phosphorus level, and an alteration in the calcium-phosphorus equilibrium with consequent mobilization of skeletal calcium and hypercalciuria.

d. *Cystinuria*

This is due to an inborn error of cysteine metabolism whereby the liver is unable to oxidize cysteine to cystine. Thus cysteine is carried to the kidneys, oxidized to cystine there, and excreted as such or deposited as crystals. In this disease the kidney tubules are unable to reabsorb the normal amount of cystine.

e. *Gout*

Gout is another metabolic disorder in which there is an error in purine metabolism with consequent hyperuricemia and urate deposition in the tissues. This disease eventually produces slow progressive renal impairment with either azotemia or urate calculi formation.

Nucleus Formation

Nucleus formation is considered a prerequisite for the formation of a renal calculus. The nucleus may consist of a small mass of epithelial cells, a foreign body (tip of catheter or surgical

sponge), a mass of bacteria or a cluster of pus cells. If the nucleus is not voided shortly after its formation, urinary salts are deposited on its surface, and a calculus develops.

Dietary Factors

Children whose diets are deficient in vitamin A and absorbable calcium show an increased incidence of vesical calculi formation. Vitamin A deficiency in rats has been shown experimentally to produce definite renal calculi. This deficiency leads to keratinization and shedding of lining epithelium which may act as the nucleus of a calculus. Ulcer patients on a prolonged regimen of Sippy diets high in calcium, phosphorus, and alkali often develop calcium phosphate calculi.

Contemporary Theoretical Factors

Randall believes that bacterial toxins concentrated by the kidney for excretion during an acute infection may devitalize the epithelium of the renal papillae. A focal area of mucosal necrosis develops, urinary salts are deposited on the denuded area, and a small calculus is created.

Carr believes that the so-called plaques of Randall are multiple concretions aggregated together in lymph channels. He contends that these concretions increase in size and finally ulcerate to give the calculi.

CLINICAL PRESENTATION OF RENAL CALCULI

One or more stones may form in the renal pelvis or calyces. These calculi are usually silent and asymptomatic until they block the urinary passages causing acute obstruction. It is then that various symptoms and signs appear.

a. Pain

This may be of three types. Dull, aching pain in the costo-vertebral angle may be constant or may occur when the patient is jolted or changes position

quickly. Pain of this nature may be due to a stag horn calculus in the renal pelvis causing obstruction and later hydronephrosis.

Renal colic, one of the most painful conditions encountered in medical practice, is caused by the passage of a small stone, a portion of blood clot or inspissated pus, oxalate crystals, or uratic debris down the ureter. It may also be caused by the impaction of a small stone at the uretero-pelvic junction or by kinking of the ureter in this area due to intermittent hydronephrosis. The pain begins in the lumbar region posteriorly, is sudden in onset, colicky in nature, and passes antero-inferiorly into the hypochondrium and medially along the course of the ureter. The pain may also involve the whole corresponding side of the abdomen, and in some cases radiates into the testis or labia in the sensory distribution of the first lumbar nerve root. The pain steadily increases in intensity to become maximum in 10-30 minutes, and without treatment, may persist for several hours. In most cases the pain is constant during the attack although slight fluctuations in severity may occur. The patient is restless, and tries to get relief by assuming various positions. Profuse sweating, nausea, and vomiting are usually present. Hematuria and pain on micturition generally follow, and the patient exhibits marked tenderness and hyperesthesia in the costovertebral angle and lumbar region.

Referred pain may occur independently or in association with the localized, dull, aching pain. This referred pain is usually noted in the inguinal region, the genitalia, and the upper part of the thigh. However, it may be referred to the contralateral lumbar region. This is a manifestation of the reno-renal reflex which involves compensatory painful hypertrophy of the healthy kidney when the affected kidney is undergoing gradual destruction.

b. *Urinary Findings*

The most constant of all urinary findings in calculous disease is the presence of red blood cells in about 85% of cases. Gross hematuria frequently occurs during or just after ureteral colic due to a stone. Pus cells and evidence of parenchymal damage are found in the urine in many cases.

c. *Physical Findings on Palpation*

A patient who has a stag horn calculus within the kidney pelvis generally has a slightly enlarged, palpable, firm and relatively nodular kidney. Secondary hydronephrosis may make the kidney palpable as an enlarged, smooth, firm mass present both in the loin and on one side of the anterior abdominal wall extending from the upper into the lower quadrant. A vesical calculus if sufficiently large may be palpated bimanually. Calculus in the urethra is frequently palpable. Tenderness is usually elicited over the affected kidney both anteriorly and posteriorly, and along the course of the ureter in the case of colic.

d. *Alteration in Voiding Habit*

A calculus in the ureter or renal pelvis may produce reflex bladder irritation, and if the stone is situated at the lower end of the ureter a marked increase in frequency and vesical tenesmus may result. A vesical calculus sets up bladder irritation due to a foreign body reaction with interruption of the urinary stream during micturition. The patient may actually pass a calculus while voiding.

e. *Anuria*

This is occasionally the presenting symptom, and may be caused by obstruction to the escape of urine due to calculi formation in both urinary pathways or by obstruction in one kidney, the other being congenitally absent, removed surgically or destroyed by disease. Reflex anuria has been postulated by Trueta to result from sup-

pression of function in the normal kidney when the opposite kidney has been disturbed suddenly by ureteral colic. Anuria may be the climax to gradually progressive renal failure resulting from long standing and extensive bilateral calculous disease.

f. *Symptoms of Infection*

Chills, fever and other septic indications occur during acute renal colic if infection is present. Low grade sepsis symptoms such as fatigue, anorexia, general malaise, constipation, and the development of anemia may appear between the acute attacks.

DIAGNOSIS

Diagnosis is based upon the history, physical examination, certain laboratory procedures, and radiological examination.

A complete urinalysis is not only routine, but may also be extremely significant.

A flat plate of the abdomen will reveal the site, size, and number of any radio-opaque calculi which are present (95% are radio-opaque). This should be followed by intravenous and retrograde pyelograms as well as cystoscopic examination and ureteral catheterization.

DIFFERENTIAL DIAGNOSIS

a. *Acute appendicitis*

Usually there is no tenderness in the costovertebral angle or loin. Microscopic urinalysis is generally negative although retrocecal and retroperitoneal acute appendices may produce abnormal urinary findings.

b. *Biliary colic*

Costovertebral angle pain is present which may radiate to the tip of the scapula, but not down to the inguinal region. Microscopic urinalysis is usually negative. Jaundice if present is diagnostically helpful.

c. *Herpes zoster*

With involvement of nerve roots T₁₂

and L₁ there may be pain in the inguinal region. The affected area becomes reddened, and shows vesicle formation 3-4 days after the onset of pain. Urinalysis is usually negative.

d. *Intestinal obstruction*

Here there is no tenderness in the costovertebral angles and generally no hematuria.

e. *Gastric crises of tabes dorsalis*

Argyll-Robertson pupils and/or loss of position sense can usually be demonstrated. Costovertebral tenderness is absent; urinalysis is usually negative.

TREATMENT

Medical treatment is begun and followed by surgical intervention if indicated.

Medical Methods

The pain of renal colic can usually be relieved by subcutaneous or in severe cases intravenous injection of morphine 15-30 mgm. and atropine sulphate 1 mgm. repeated in 3-4 hours if necessary. Recently it has been shown that Bantline 100-200 mgm. intravenously will relieve such pain in a matter of minutes.

All available methods of promoting diuresis should be utilized. These include forcing fluids to create a dilute urine, and the use of such drugs as Caffeine, Aminophylline, and Digitalis. Hot packs or hot air baths will promote the excretory activity of the skin and the administration of saline purgatives increases the loss of fluid by bowel.

The patient should undergo a complete investigation in order to rule out specific causes for his calculi.

If X-ray films show that calculi are causing obstruction of the upper urinary tract and anuria, then the obstruction should be relieved by immediate catheterization of both ureters.

Dietary Methods

Vitamin A administration is of speculative value. Cystine stones can be pre-

vented and perhaps even reabsorbed by reducing the protein intake to a minimum and by giving alkalies to keep the urine constantly alkaline.

A diet low in calcium and phosphate and combined with oral aluminum hydroxide and estrogens is theoretically sound. It is based on the concept that estrogen produces an increased urinary excretion of citric acid which combines with calcium phosphate to form a soluble calcium citrate complex. The aluminum hydroxide gels divert the phosphate excretion from the urinary tract to the intestinal tract thus causing a lower phosphate concentration in the urine.

Surgical Methods

Surgery is indicated when calculous anuria persists in spite of ureteric catheterization and other non-operative medical procedures.

a. *Pyelotomy*

This procedure should be used when the stone is known to be in the renal pelvis.

b. *Nephrectomy*

This is only indicated if the calculous disease is far advanced.

c. *Ureterolithotomy*

The ureter may be incised over the calculus and the calculus removed. If the stone is low in the ureter and not too large, a wire basket may be passed into the ureter and the stone removed in this manner.

BIBLIOGRAPHY

1. Nesbit and Baum: Fundamentals of Urology, 1953.
2. Winsburg-White: Stone in the Urinary Tract, 2nd Edition, 1954.
3. Cape, Z.: The Early Diagnosis of the Acute Abdomen, 10th Edition, 1951.
4. Bailey, H.: Physical Signs in Clinical Surgery, 12th Edition, 1954.
5. Moseley, H. F.: Textbook of Surgery, 2nd Edition, 1955.
6. Davidson, S.: Principles and Practice of Medicine, 3rd Edition, 1956.
7. Harrison, T. R.: Principles of Internal Medicine, 2nd Edition, 1954.
8. Conn, H. F.: Current Therapy, 1955.

DIFFERENTIAL DIAGNOSIS OF HEMATURIA

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HEMATURIA is a symptom defined as an Addis Count of over 500,000 erythrocytes in a twelve hour sample of urine. It has many causes, and the cause of the bleeding must be established in each and every case. An effort will be made to classify bleeding from the urinary tract, and to outline methods of investigation. A good approach to the problem of hemorrhage is an anatomical one, dividing the urinary tract into upper and lower components. The upper component includes the kidneys and ureters; the lower, the bladder and urethra. Urethral bleeding may be prostatic or anterior urethral in origin.

Diagnosis is often easier when the examiner sees the patient while the bleeding is occurring. The patient should be instructed where possible not to void until reaching the clinic. There he should pass his urine into three glasses while under observation. If bleeding is still present, the three glass test shows the relationship of blood to various parts of the urinary tract. Blood in the first glass alone, whether slight or marked, is certainly urethral in origin. Blood in the last glass alone, or at the end of micturition, incriminates a bladder lesion. Total hematuria will present homogeneous red or reddish-brown urine in all three glasses. In mild cases smoky urine appears. Total hematuria suggests a lesion in the urinary tract anywhere above the trigone. Occasionally a prostatic lesion will produce total hematuria.

Hematuria associated with painful urination and frequency is usually infective in origin. Infections, however, may be secondary to other lesions (calculus or neoplasm). Hematuria of neoplastic origin may occur intermittently and is sometimes profuse without pain. Tran-

sitional cell carcinoma of the bladder, the commonest vesical neoplasm, may present with severe pain and infection in the late stages.

Bleeding may follow a history of trauma with blood and clots in the urine. Calculi may produce bleeding by infection and minor mucosal trauma. Pain is a frequent symptom, colicky in ureteral calculi, but referred to the tip of the penis if the stone lies in the bladder. Stones seem to be rare in the female urinary tract. Some 2-3% of cases of hematuria present no bleeding lesion. Histories range from severe single hemorrhages to repeated episodes of minor blood loss. The only consistent finding at autopsy has been minor multiple endotheliomata of the renal pelvis. Such disturbing cases must be classified as idiopathic or essential hematuria.

LOWER SEGMENT

BLEEDING FROM THE URETHRA

Urethral bleeding is comparatively rare. Mild to severe hemorrhage unassociated with micturition or the appearance of blood at the onset of voiding is the localizing sign. If associated with micturition, blood appears in the first glass of a three glass test.

Benign Neoplasms

These include angioma, condyloma, fibroma, papilloma, polypus and caruncle. Bleeding may be mild or extremely profuse, and is associated with retention in some cases. Urethroscopy confirms the diagnosis of neoplasm if performed by a capable observer.

Malignant Neoplasms

Carcinoma and sarcoma of the urethra, although rare, must be considered for completeness. They occur much more

frequently in women, and are characterized by a blood-tinged mucoid urethral discharge unrelated to micturition. When malignant neoplasm does occur, pain is a common symptom in the female. The diagnosis can be made with the aid of the urethroscope and biopsy of the growth.

Impacted Calculus

Hematuria here follows the general rules for urethral bleeding mentioned above. Blood appears in small quantities as bleeding is due to mucosal trauma by the stone. Retention may occur, and penile or vulvar pain is not uncommon. Palpation along the course of the urethra will usually reveal the calculus.

Sympexia

Mild hematuria is most commonly caused by small submucosal granular collections of black pigment in the posterior urethra of both sexes. These are easily seen on urethroscopic examination.

Trauma

Tearing or crushing of the bulbous urethra occurs after a fall astride a rail or when sliding over the edge of a jeep or wagon. Blood often appears at the meatus in this type of injury, but this is not hematuria since there is no urine mixed with the blood. Retention is the rule, but the patient should be warned not to pass his water. If voided, the urine extravasates under Colles' fascia. There is severe urethral pain and catheterization fails. The catheter commonly passes into the hematoma with an increased flow of blood from the instrument.

Prostatic Hyperplasia

A rare symptom in prostatism is total hematuria appearing intermittently. Diagnosis is possible by cystoscopic and rectal examination.

Prostatic Infarction

When infarction occurs, hematuria, is a common symptom, but diagnosis is difficult. Occasionally a dark red patchy area of mucosa over the infarcted area can be seen through the cystoscope.

Idiopathic

A small percentage of urethral hematurias go unexplained. Some attacks are profuse, but the majority show mild and intermittent bleeding.

BLADDER

Neoplasms

These include papilloma, papillary carcinoma and non-papillary carcinoma. The initial symptom in these lesions is often hematuria. Fifty per cent of all cases of gross hematuria are attributable to vesical neoplasms. Hematuria at first appears silently, intermittently, and is of moderate amount, but may progress to massive hemorrhage. Total hematuria is always seen. Diagnosis may be made when a tumor is felt on abdominal examination associated with frequency of micturition and dysuria. Cystoscopy is essential in every case to confirm the diagnosis, and if necessary cystography may show deformity of the bladder due to extra-vesical growth.

Cystitis

Bleeding is common in both the acute and chronic forms of cystitis. Microscopic examination of urine must be employed in most instances. Gross hematuria rarely occurs. Suprapubic tenderness reveals an involved bladder. Sometimes there is a pyuria in the acute form. Cystoscopy when feasible may reveal an edematous, engorged mucosa. Ecchymoses of the mucosa are seen in acute hemorrhagic cystitis which is characterized by sterile urine and sudden hemorrhage continuing for 24-48 hours. Bleeding usually occurs spontaneously.

Hunner described a common condi-

tion which is termed interstitial cystitis. It presents a constant microscopic hematuria due to a recurring but rapidly healing ulceration of the bladder mucosa.

Vesical Calculus

Calculi may be suspected when traces of blood appear in the terminal urine associated with increased frequency. Exercise may aggravate the bleeding. Pain is characteristically referred to the tip of the penis when the stone rests on the trigone. Patients are commonly male, and may give a history of previous calculi or colic. Cystography will reveal the stone in the bladder in most cases.

Trauma

If total hematuria associated with tenesmus and retention follows an accident, bladder damage may be the cause. Cystoscopy and catheterization should be employed for diagnosis. There is often extreme difficulty in observing a tear in the bladder wall. Intravenous urography is a useful procedure in such cases. Injection of a known quantity of saline and its withdrawal for measurement is generally useless as a test for bladder leakage. Some of the solution may lie below the catheter tip behind a hypertrophied prostate, and if the bladder has ruptured, fluid may leak from the peritoneal cavity into the organ.

Radiation-induced Telangiectases

Bladders in pelvis radiated for control of carcinomatous metastases may show submucosal telangiectases which tend to rupture. Slight amounts of blood appear in the urine, and bleeding occurs intermittently. Diagnosis can be made easily by the history of radiation and cystoscopic examination of the bladder mucosa for the suspected lesions.

UPPER SEGMENT

URETER

Ureteric Calculus

Calculi in the ureter commonly pro-

duce a small amount of bleeding as they pass or when they partially block the tube. Occasionally bleeding may be profuse. The problem is usually easily recognized by the history of typical colic and the symptoms of frequency, urgency, dysuria, urethral pain, and referred pain to the bladder, rectum or perineum. Antero-posterior and lateral X-ray films of the abdomen give diagnostic proof of calculi in 95-97% of cases. Obstructed cases may reveal hydronephrosis. Retrograde urography usually reveals the stone in the ureter.

Neoplasms

The bleeding in these cases may be profuse causing total hematuria. The patient complains of unilateral renal pain. Cystography reveals blood oozing from the affected ureter. A filling defect may be revealed by intravenous pyelogram, and is usually diagnostic of a neoplasm.

Both neoplasms and calculi in the intramural portion of the ureter may show a localized ureteritis with edema and ecchymoses in the overlying mucosa when cystoscoped. Occasionally the intraureteral mass can be felt vaginally or rectally.

KIDNEY AND RENAL PELVIS

Tuberculosis

Profuse total hematuria is a common symptom in renal tuberculosis. It occurs early and may become frequent. Although initially renal, eventual bladder involvement causes hematuria at the end of micturition with terminal pain between the attacks. These symptoms in a young adult associated with a dull, constant renal ache and sterile pyuric urine suggest renal tuberculosis. Urinary sediment should be examined for tubercle bacilli. Roentgenography of the urinary tract may disclose renal enlargement and irregularity of surface

contour strongly suggestive of the tuberculous lesions. Calcification if present is of value in diagnosis, but it occurs in chronic pyelonephritis, pyonephrosis, and renal tumors as well.

Neoplasms

Hematuria associated with dull aching loin pain and a palpable mass strongly suggests a renal neoplasm. Hypernephroma is the commonest cause in adults. Its progressive growth involving the renal pelvis and blood vessels may cause profuse intermittent hematuria with worm-like or pyramidal casts. The most significant diagnostic investigation is the intravenous pyelogram. Distortion of the renal pelvis and calyces is frequently present.

Trauma

Kidney trauma frequently produces hematuria varying in severity. Diagnosis is rarely difficult, but a complete urinary tract examination including an intravenous pyelogram is indicated to rule out any underlying pathology. In the Toronto General Hospital 27% of all ruptured kidneys treated showed a pre-existing renal lesion.

Renal Calculus

Urinary tract bleeding due to renal calculus is seldom profuse, but may be continued and associated with a slight pyuria. The patient may complain of loin pain. Roentgenography should reveal the stone in about 95% of cases.

Hydronephrosis

Hematuria in this lesion has no particular characteristics other than always being total. The patient may complain of loin pain, and he may have felt a mass. A distinguishing feature from renal neoplasm is the fluctuant nature of the hydronephrotic mass. Intravenous pyelogram will also differentiate hydronephrosis from renal neoplasm.

Polycystic Disease

Hematuria is a common symptom in the late stages of this disease. Pain, smooth rounded bilateral masses, and polyuria with urine of low specific gravity all cast suspicion on polycystic disease. Characteristic pyelogram shadows show elongated calyces with large rounded cavities.

Nephritis

Nephritis is almost always accompanied by varying degrees of hematuria. The condition may be recognized by the other symptoms and signs. Cases of acute nephritis show edema and hypertension with severe hematuria. More chronic types may have edema and smoky urine with abundant albumin and many types of casts.

Essential Hematuria

A small percentage of renal hematurias are idiopathic. The bleeding is unilateral, profuse and sudden with unexplained onset and accompanied by loin pain. Albuminuria does not occur between attacks.

Drugs

Treatment with certain therapeutic agents may cause a minimal to obvious hematuria. Some drugs such as the Sulphonamides do so by the formation of renal crystals when their concentration in the urine rises. Other drugs causing hematuria are dicoumarol, sodium salicylate, turpentine, and phenol. Treatment with one of these drugs at the time of bleeding suggests its guilt, especially if cystoscopic and intravenous pyelogram investigations are negative.

EXTRA-RENAL DISEASE

Carcinomatous Spread

The bladder is commonly involved by metastases from malignant neoplasms of the rectum, pelvic colon, vagina and uterus. Bladder wall involvement may cause vesical irritability followed early

by profuse hematuria. This type of hematuria usually takes place late in the history of the neoplastic process. Cystoscopy may reveal ecchymoses and tumorous involvement of the bladder wall. Encroachment upon the bladder may appear in retrograde urography films.

Pelvic and Abdominal Inflammations

Acute salpingitis, pelvic abscess, acute appendicitis, and diverticulitis may give rise to hematuria when the bladder wall becomes involved. Localized thickening with edema and ecchymoses point to the cause. A history of localized pain in the area of the appendix or fallopian tubes associated with pyrexia and peritoneal irritation may reveal the cause.

Renal Infarction

Systemic embolism occasionally causes renal infarction with resultant hematuria. Sudden, unilateral pain preceding the bleeding, exquisite pain in the loin, a rise in temperature, and an elevated white blood count are some of the other characteristic findings. Renal infarction is extremely difficult to diagnose. Cystoscopy should be done when the patient

is well enough in order to rule out other pathology.

Blood Dyscrasias

Such disease entities as hemophilia, purpura, and the leukemias may be associated with hematuria, but the diagnosis depends upon blood and bone marrow examination rather than the usual urological methods of investigation.

Scurvy

Hematuria is only one of the many types of hemorrhage seen in this disease. Usually there are other obvious signs of bleeding. The blood shows a hypochromic anemia, and the diet is lacking in vitamin C.

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BIBLIOGRAPHY

1. Brayley, J. L.: University of Toronto Medical Journal, Jan., 1951.
2. Campbell, M.: Urology, 1954.
3. French: Index of Differential Diagnosis, 6th Edition, 1945.
4. Herman: Practice of Urology, 1938.
5. Pender and Robinson: Diagnosis and Management of Urological Cases, 1955.

BLADDER DYSFUNCTION IN NEUROLOGICAL LESIONS

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INFANT BLADDER

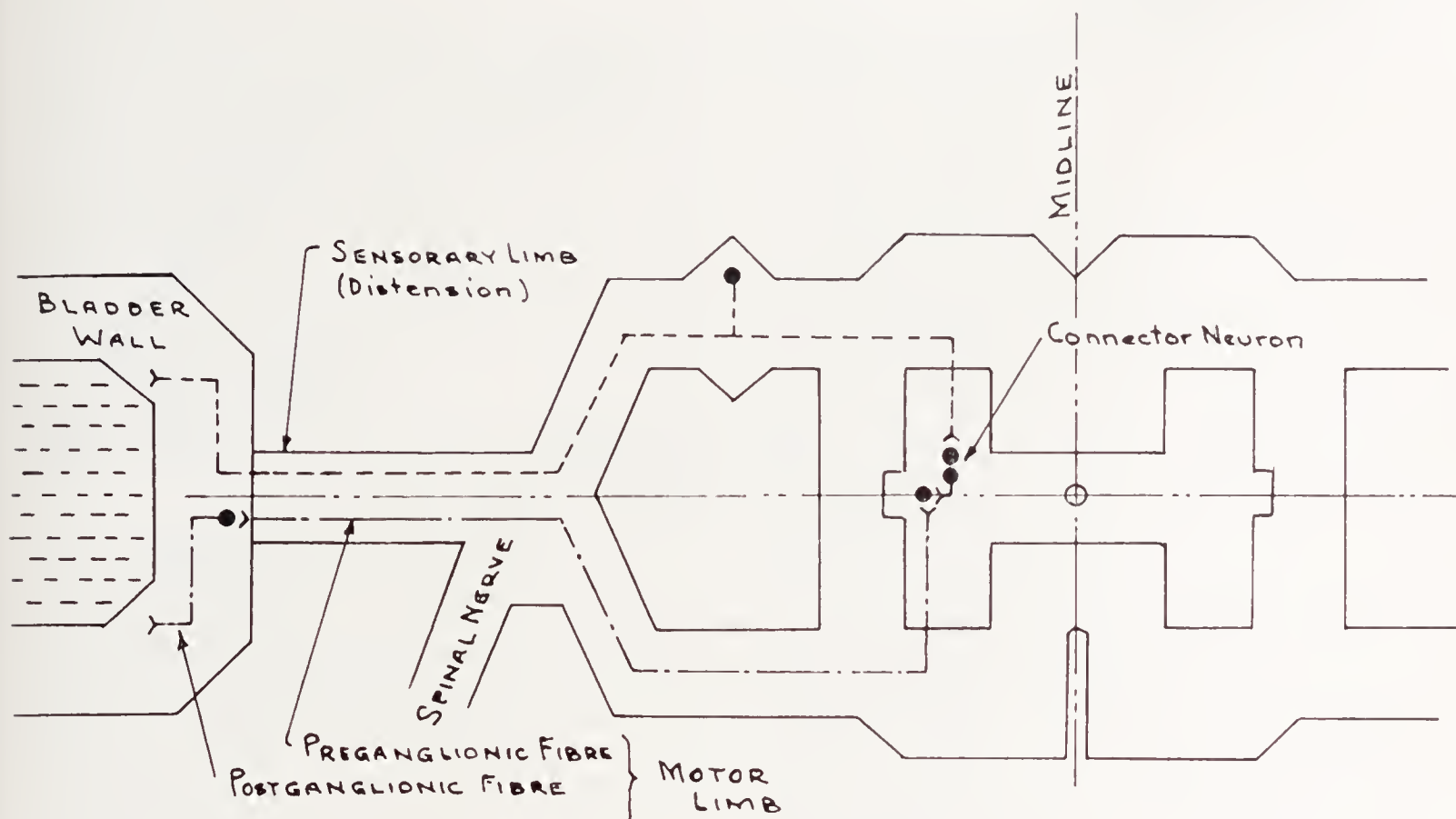
IN infancy and very early childhood, the bladder is controlled by a simple reflex arc synapsing in the sacral portion of the spinal cord. The afferent and efferent fibres are mediated mainly through the pelvic splanchnic nerves ($S_{2, 3, 4}$) which are part of the parasympathetic nervous system. Stretch receptors in the detrusor (bladder) muscle are stimulated by filling of the bladder thereby setting up impulses which travel along the afferent limb whose cell body

is in the dorsal root ganglion to synapse with a connector neuron in the dorsal horn gray matter. The connector neuron then synapses in the lateral part of the gray matter with the preganglionic neuron of the efferent limb, and this in turn synapses with the postganglionic neuron in the bladder wall. The postganglionic fibre ends at a neuromuscular junction of the detrusor muscle. There are thus four neurons required for this simple spinal reflex.

Following stimulation of the stretch

receptors in the detrusor muscle, a series of uninhibited contractions of steadily increasing amplitude occurs until finally a massive contraction causes the bladder to empty spontaneously.

thalamic tracts (pain and temperature) and the uncrossed touch paths (distension) to reach the thalamus and consciousness. The motor fibres in the spinal cord lie lateral to the pyramidal tracts



SIMPLE REFLEX ARC IN HUMAN INFANT

ADULT BLADDER

During childhood a suprasegmental reflex becomes incorporated into the mechanism of micturition. The nervous control of the normal adult bladder then consists of a simple spinal reflex combined with a suprasegmental reflex. The connector neuron at the spinal level becomes dormant, and is replaced by a connector neuron at the cortical level. The suprasegmental reflex is dominant over the spinal reflex, and places the spinal reflex under the control of a cerebral center. This center has been described at the superior part of the motor area of the cerebral cortex on the medial aspect of the hemispheres. The afferent impulses arising from the bladder are transmitted up the lateral spino-

intermingled with the spinocerebellar fibres.

The neurological pathway controlling micturition can thus be simplified to consist of five neurons:

1. An afferent neuron from the sensory receptors in the bladder (pain, temperature and distension) to the sacral spinal cord.
2. An afferent neuron from the sacral spinal cord up to the sensory area of the brain.
3. A connector neuron from the cortical sensory area to the cortical motor area.
4. An upper motor neuron from the cortical motor area down to the sacral spinal cord.

NEURO-PATHOLOGICAL BLADDER

I. *Uninhibited Type**Lesion*

Destruction of, or interference with, the upper motor neuron anywhere along its length.

The entire sensory part of the total reflex is intact as is the lower motor neuron segment. In addition the previously quiescent spinal connector neuron regains its activity to complete the spinal reflex. Consequent upon the loss of cerebral control, uninhibited contractions of the detrusor muscle occur while the bladder is filling. These contractions each subside until one of sufficient intensity occurs, and necessitates uncontrolled emptying of the bladder.

Since the sensory limb is complete up to the cerebral cortex, the patient is completely aware of all events occurring in his bladder, and interprets each uninhibited contraction as a desire to void.

Etiological Conditions

A. Congenital: where the normal integration of the cerebral inhibitory mechanism (suprasegmental reflex) has not properly developed.

B. Acquired:

1. Cerebro-vascular accidents.
2. Brain tumors.
3. Multiple sclerosis.
4. Subacute combined degeneration of the cord.
5. Syringomyelia.
6. Spinal cord tumors.

Symptoms

The patient has difficulty in initiating the act, and he cannot retain his urine at will: when the desire comes he must respond to it immediately. As a result there is increased frequency with urgency 24 hours a day.

Treatment

The essential problem in this type of

bladder is to control the uninhibited contractions of the detrusor muscle. Drug therapy using a ganglionic blocker such as Banthine in a moderate daily dose orally usually blocks most of the aberrant motor impulses, thereby permitting the patient more normal micturitional habits.

II. *Reflex Type**Lesion*

Destruction of, or interference with, both motor and sensory limbs of the suprasegmental reflex.

As a result, not only does the patient have no control over micturition, but also, since the sensory limb of the suprasegmental reflex has been interrupted, he does not even know what is going on in his bladder.

This complete removal of cerebral control reverts the bladder to the status of a simple reflex organ whose activity is dependent solely upon the primary reflex arc through the sacral spinal cord. The infant presents the normal reflex bladder, its suprasegmental reflex conditioning not having become integrated; the acquired reflex bladder represents the pathologic type, its suprasegmental reflex conditioning having become disintegrated. Both perform in roughly the same manner although for unexplained reasons, the reflex bladder of the infant is more efficient.

This type of bladder is still capable of initiating sensory impulses even though these impulses never reach consciousness, and of responding to lower motor neuron impulses since the spinal reflex arc remains intact.

Etiological Conditions

1. Complete transection of the spinal cord.
2. Gross cord lesions as in transverse myelitis and severe subacute combined degeneration and multiple sclerosis.

Characteristics

Micturition is completely reflex, and the ability to initiate or cause cessation of the act at will is lost. Although bladder sensation is lost, some patients have headache and sweating as a warning of impending bladder contraction prior to micturition.

In diffuse spinal cord lesions such as subacute combined degeneration and multiple sclerosis, the bladder capacity is often sufficient to be well tolerated. Such bladders can often be trained to empty at 3-4 hour intervals, and have been called "normal" acquired reflex bladders.

Unfortunately, however, reflex bladders of small capacity are the most common, and are seen most often in patients who have a generalized spasticity of the extremities following a complete transection of the spinal cord. The bladder in these patients seems to reflect their general spasticity, and empties precipitously.

Complications

The first of these results from incontinence which with the consequent odour may form a serious social handicap for the patient. The second depends on the residual urine following failure of the bladder to empty completely. This eventually initiates a series of infection progressing through cystitis, pyelonephritis, and pyonephrosis, especially if the residual urine volume is greater than 20% of the bladder volume.

Treatment

The treatment of this type of bladder is mainly treatment of the complications. Urinary incontinence per se cannot be corrected definitively, but soiling can be prevented by the use of appliances attached to the penis. The volume of residual urine may be decreased by decreasing the resistance to outflow. Transurethral resection of the bladder neck or pudendal nerve section to reduce

tonicity of the external sphincter may achieve this effect. Such procedures should then be followed by the use of a collecting appliance.

III. *Autonomous Type*

Lesion

Destruction of, or interference with, both motor and sensory roots of the spinal cord reflex arc.

As a result the bladder is under no nervous control at all; its status now is that of a distensible muscular bag. After a period of retention with overflow, the bladder may partially expel its contents automatically. It is postulated that local reflex arcs through the ganglion cells in the bladder wall are responsible for this automatic action.

Etiological Conditions

1. Traumatic lesions of the lumbosacral spine involving the conus or cauda equina.
2. Regional neoplasms.
3. Congenital abnormalities — myelomeningocele, spina bifida.
4. Abdomino-perineal resections during which procedure the pelvic splanchnic and pudendal nerves may have been sectioned or injured.

Treatment

This is directed at reduction of the high residual urine volume with its resultant overflow incontinence and inevitable infection. Periodic forceful evacuation of the bladder may be of value using the forces of the lowered diaphragm, the contracted abdominal musculature, and self-Crede of the bladder by manual pressure over it. These manoeuvres are possible because sacral cord lesions spare the upper extremities and the abdominal muscles.

Transurethral resection of the internal sphincter will enhance emptying, but evacuation is still only accomplished by the forces listed above. There is a theoretical possibility of complete incontin-

ence following this procedure since the lesion often involves the pudendal nerve ($S_{2,3,4}$) in which case the external sphincter is in a state of flaccid paralysis; however, for unexplained reasons this does not occur.

IV. *Sensory Paralytic Type*

Lesion

Destruction of, or interference with, the sensory limb of the spinal or suprasegmental reflex arc.

In this type of bladder the desire to void is absent consequent upon the loss of sensation resulting in prolonged overdistension. Eventually, if the bladder is not emptied, the detrusor muscle becomes atonic, overflow incontinence occurs, and a large volume of residual urine is always present. However, since the motor limb of the reflex arc—both upper and lower motor neurons—is intact, the patient still has voluntary control over micturition, and he can initiate the act at will. If he replaces the normal desire to void by periodic voluntary straining, reasonably normal micturitional habits can be established. Evacuation, however, is never complete, and residual urine remains a problem.

Etiological Conditions

1. Tabes dorsalis.
2. Subacute combined degeneration of the cord.
3. Multiple sclerosis.
4. Diabetes mellitus.
5. Syringomyelia.
6. Progressive muscular atrophy.

Treatment

The patient should be instructed to void periodically by voluntary straining, thereby preventing the accumulation of residual urine, and at the same time achieving a highly satisfactory degree of continence and preservation of bladder tone. If the residual urine is sufficient to cause infection and symptoms, it can often be reduced by increasing the fre-

quency of voluntary evacuation to q.2h, and by aiding evacuation with self-Crede. If these measures prove inadequate, transurethral resection of the internal sphincter is indicated.

The use of parasympathomimetic drugs in the hope of stimulating the detrusor muscle has been disappointing.

Where the patient is bedfast and incapable of voluntary micturition because of generalized illness, constant drainage by urethral catheter or suprapubic cystostomy should be instituted.

V. *Motor Paralytic Type*

Lesion

Destruction of, or interference with, the lower motor neuron.

Normal sensation is present since the entire sensory limb is intact. When the bladder becomes filled, the patient complains of painful distension, since evacuation either reflex or voluntary is impossible. If immediate catheter drainage is begun, the detrusor muscle tone will remain normal. If it is not, the bladder will distend, overflow, decompensate, and become atonic.

Etiological Condition

Poliomyelitis.

Treatment

Catheter drainage should be continued throughout the period of motor paralysis.

Prognosis

In patients suffering from bladder disturbance due to poliomyelitis, the neuron dysfunction is of relatively short duration, and return of bladder function can be expected early, provided the bladder musculature has been protected by prompt and adequate drainage.

BIBLIOGRAPHY

1. Best and Taylor: *Physiological Basis of Medical Practice*, 6th Edition.
2. Nesbit and Baum: *Fundamentals of Urology*, 1953.
3. Samson Wright: *Applied Physiology*, 9th Edition.

OBSTRUCTIVE UROPATHY—PROSTATISM

N. D. KERR, 5T8

PROSTATISM is a term used to describe a condition in which urinary obstruction of prostatic origin occurs.

NORMAL PROSTATE

The prostate is the most important accessory sex gland in the male. It weighs about 20 grams and is located in the space below the bladder orifice, behind the inferior surface of the symphysis pubis, above the urogenital diaphragm, and in front of the rectal ampulla. Because of its anatomic location, strategically surrounding the posterior urethra and vesical orifice, disease of the gland produces symptoms of lower urinary obstruction.

The gland is made up of five lobes: two lateral and one middle and two insignificant anterior and posterior lobes which give the gland a horse collar shape around the urethra. The alveoli of the lobes are lined with columnar epithelium and are embedded in a thick fibromuscular stroma. These drain by ducts into the floor and lateral surfaces of the posterior urethra. There are three main diseases which cause prostatism in adult life:

1. Benign prostatic hypertrophy.
2. Median bar.
3. Carcinoma of the prostate.

Benign Prostatic Hypertrophy

Incidence

Prostatic obstruction occurs with increasing frequency in each decade from the age of 40 onward. This type is responsible for 80% of all bladder neck obstructions. With the increase in longevity in the past quarter century, there has been a great increase in the number of males living into the "prostatic age". About 65% of all men between the ages

of 60 and 70 have some obstructive symptoms.

Etiology

There are three theories of the origin of benign hypertrophy, none of which have been adequately proven:

1. Chronic infection.
2. Vascular changes due to senility.
3. Hormonal imbalance.

Pathology

The median or one of the two lateral lobes or a combination of all three lobes are always involved. The posterior lobe is seldom involved while the anterior is enlarged rarely. The growth is mildly neoplastic in character with the development of spheroids or nodules which have multiple sites of origin and grow without limit as to size.

Grossly these are localized areas of distinct adenomatous appearance. They are surrounded by a thin layer of prostatic tissue called the compression capsule which lies between the hypertrophic mass and the true fibrous capsule of the gland. These tumors usually enlarge symmetrically, giving rise to either bilobular (two lateral lobes) or trilobular (two lateral plus the median) enlargements.

Lateral Lobe Hypertrophy

This configuration grows to surround the prostatic urethra which becomes quite elongated. This tumor may confine itself within the prostatic capsule without projecting up into the vesical orifice. Here the lobes grow to great size with little obstruction. On other occasions the lobes extend into the region of the vesical orifice and project into the bladder. This interferes with the function of the vesical orifice causing obstruction.

Median Lobe Hypertrophy

This begins in the posterior urethra, and following the line of least resistance, projects up as a mass through the vesical orifice into the bladder. This type is likely to cause hypertrophy of the proximal trigonal muscle and commonly forms a post-prostatic pouch.

Median Bar

This type of benign hypertrophy also results in gross configuration of the bladder outlet.

Incidence

This occurs at a slightly earlier age than benign hypertrophy and accounts for about 10% of all prostatism.

Etiology

The cause is obscure. Some hormonal disorder in the ratio of androgens to estrogens is thought to be involved.

Pathology

Most types begin as a nodule of fibromuscular tissue or epithelial tissue derived from the suburethral glands. The posterior lip of the vesical neck is contracted, foreshortened, and elevated in the form of a dam.

Rectal examination usually reveals a normal sized prostate since the median bar enlargement is not palpable. Definitive diagnosis is only obtained by direct visualization through the cystoscope.

*Carcinoma**Incidence*

This affects 5% of all men who reach the age of 60. One out of five glands removed for benign hypertrophy shows histological evidence of cancer.

Pathology

About 90% begin in the posterior lobe. It is an adenocarcinoma and grows slowly, gradually invading the whole gland, and extending beyond the capsule into the seminal vesicles and by direct

continuity into the structures of the pelvis. It may extend around the ureters proximal to their entrance into the bladder giving rise to ureteral obstruction even though there is little or no bladder neck obstruction.

PATHOLOGY OF URINARY OBSTRUCTION

Urethra

This is always affected in prostatism and its length is usually increased. In the lower part its shape is influenced by the enlargement of the two lateral lobes which frequently compress it so tightly as to present great difficulty in passing a catheter. An increase in the upper part of the lobes has little effect on the urethra as the bulging is mostly upward.

Bladder Changes

In cases where the symptoms are at all severe a post-prostatic pouch is formed. This is due to elevation of the urethral orifice and depression of the vesical floor, and is probably more frequently a cause of urinary retention than is a pedunculated middle lobe. In voiding great strain is needed to effect complete evacuation past the elevated urethral orifice. Due to the constant strain, it naturally becomes depressed with each effort to empty itself, and the pouch may attain a very considerable size.

The effect on the bladder wall is more or less constant. The bladder musculature will adapt itself up to a point to the increased demands for work that are imposed on it. Minor degrees of obstruction produce little subjective disturbance and the bladder is easily able to force urine past. But if significant obstruction is present, the bladder is called upon to use increased effort in order to evacuate its contents and as a result the musculature undergoes compensatory hypertrophy: the wall becomes thickened and individual muscle bundles enlarge and appear as gross trabeculations. The increased hydrostatic pressure within the

bladder causes the mucosa to become stretched tightly over these trabeculations making them prominent.

When incomplete obstruction is continuous, the bladder eventually begins to decompensate, its weakened musculature is unable to empty the viscus completely, and post-micturitional residual urine is always present. The rate of bladder decompensation varies in each case and depends on nutrition, infection, variation in the amount of obstruction, and the condition of the nerves to the bladder.

When complete decompensation occurs, the bladder becomes a flaccid sac incapable of contraction and evacuation is by overflow. If the patient is unconscious or asleep, he will urinate incontinently by continuous dribbling, but when conscious he can manage to remain continent by voluntary effort and by forceful contraction of his abdominal muscles.

Kidneys and Ureters

If prostatic obstruction has remained for any considerable length of time, these structures cannot escape involvement. Normally each ureter enters the bladder wall obliquely, crossing from one-quarter to one-third of an inch through the vesical coats. This valve-like structure causes the urine to pass into the bladder in spurts. However, when a moderate to large amount of residual urine is present, it distends the bladder walls compressing the valve openings, and makes it difficult for the urine to be expelled from the ureters. This results in a damming back of urine into the ureters and then the kidney pelvis causing hydronephrosis and hydronephrosis. As the back pressure increases, the ureters and pelvis become progressively distended. Urine is still being formed and reabsorption, either by the tubules or pyelovenous backflow from the pelvis, now occurs.

Eventually renal ischemia and disease result in degeneration and atrophy of the kidney. Infection will cause pyonephrosis with resulting chills, fever, and pyuria. The end result is anuria, uremia, coma and death.

It is to be emphasized that these final changes can occur rapidly or slowly depending on the degree of obstruction at the bladder neck and the length of time it has been present. This hydronephrotic state is becoming less common inasmuch as the "Prostatics" usually present themselves for treatment before kidney changes occur.

SYMPTOMS OF PROSTATIC OBSTRUCTION

Many of the patients with hypertrophy of the prostate present few or no symptoms whatsoever of their disease. Only about one in seven who have enlarged prostates suffer any inconvenience or are aware of their condition—so insidiously do the symptoms develop—until acute retention of urine points to the prostate as the cause of their trouble.

The following symptoms are described as they theoretically occur, but it must be remembered that patients vary in their reaction to bodily dysfunction. Hence, a doctor may not see his patient until the end stages of chronic retention have occurred, or conversely, an intelligent patient will seek medical advice at the first sign of increased frequency.

Irritation

In the early stages there is increased frequency and nocturia. If the urine is infected, a burning sensation during micturition may be present. There is often some urgency, but there is little or no difficulty in urination. A normal sized stream is present, and there is no residual urine.

Obstruction

In the next stage there is a continuation of the first stage with an increase in frequency and nocturia. A triad of symp-

toms is seen: difficulty in initiating the act; a decrease in force; dribbling and incontinence at the end of micturition. There may or may not be residual urine at this stage, depending on the state of compensation of the bladder and the degree of obstruction. Instead of relaxing and becoming funnel-shaped as in the normal, the neck of the bladder becomes rigid; the longitudinal fibres cannot contract and the prostatic urethra cannot dilate and form part of the bladder. Therefore, this first part of the urethra, instead of being filled with urine ready to pass, has to be filled by force from above. This is the reason for the difficulty and delay.

Involuntary dribbling is the first symptom of commencing failure of the bladder musculature due to the incompetence of the vesical sphincter. The dribbling is constant, yet the bladder is never empty.

From this impairment residual urine is produced, although the patient may be entirely unaware of it. The bladder has failed to completely empty itself, and an amount varying from a few drops to many ounces is retained, depending on the degree of obstruction.

Renal Insufficiency

The back pressure from retention of urine eventually causes impairment of renal function. The patient develops gastro-intestinal symptoms, anorexia, constipation, depression of higher centers, general debility, and in advanced states uremia with coma and/or convulsions.

Infection

Residual urine sooner or later, and usually sooner, becomes contaminated, not from its mere presence in the bladder, but usually from without. Catheterization is the most potent cause of cystitis so certain to develop in the majority of cases of marked hypertrophy.

The catheter introduces infection, the mucous membrane becomes congested, and pus and debris are deposited in the bladder. This settles in dependent parts of the bladder (post-prostatic pouch) and cystitis rapidly develops. The symptoms of infection introduced into a chronically obstructed urinary tract with residual urine include:

a. An increase in all bladder symptoms so that urination becomes painful and frequent.

b. Urgency and strangury.

c. Increased hesitancy.

d. With infection of the hydronephrotic kidney by blood stream spread or retrograde from the bladder, the patient has chills, fever, nausea, vomiting, anorexia, and pain in the loin on the affected side. The factor of renal insufficiency is increased as well since the kidney, already working under a handicap, is further insulted by a superimposed pyelonephritis.

Hematuria

This is seen in a small percentage of cases, and is due to:

a. Catheterization.

b. Ulceration of bladder mucosa due to prolonged cystitis or congestion.

c. Varicose veins in the prostatic urethra which rupture.

Pain

Pain is felt suprapubically when acute retention is present. Chronic retention usually produces no pain.

Cystitis

Infection accompanies all cases of long standing obstructive prostatism. This is recognized by the passing of a thick, stringy, mucoid or cloudy urine.

DIAGNOSIS

History

Any man over 50 complaining of abnormalities in urination should be suspected of having prostatism.

Examination

a. Palpation and percussion of the suprapubic area to determine if the bladder is enlarged.

b. Rectal examination: all enlargements of lateral lobes and most malignancies can be palpated, but absence of any abnormality does not exclude this diagnosis. Be sure the bladder is decompressed first since bulging of its floor will accentuate the apparent size of the prostate.

c. Complete urinalysis.

d. Catheterization for residual urine: rapid catheterization of an enlarged bladder may lead to a sudden shocked state. Decompression must be gradual, and may take several days or weeks, depending on the amount of urine retention. Do not catheterize the patient if he has (1) a palpable non-tender bladder or (2) uninfected urine since you may introduce infection. Either prepare him a day ahead with urinary antibiotics, or better still, hospitalize him for a complete genitourinary examination. In hospital better aseptic conditions prevail thus decreasing the danger of serious complications following introduction of infection or trauma from instrumentation. The differential diagnosis of residual urine must also include: neurogenic bladder, hysteria, urethral stricture, and diverticulum of bladder.

e. If a diagnosis cannot be made by the above methods, then instrumental visualization of the urethra and bladder should be done.

Special Procedures

1. *Intravenous Pyelogram*: An IVP is an excellent test of kidney function. It is also of value in the detection of hydronephrosis, renal calculi, neoplasms, and congenital anomalies.

2. *Cystogram*: This may show an intravesical protrusion of an enlarged prostate not evident on rectal examination.

In addition it may show evidence of trabeculations, vesical calculi and bladder diverticuli.

3. *Cystoscopic examination*: This method usually clinches the diagnosis, and is a very necessary preoperative requirement. It rules out the above mentioned lesions as well as intravesical neoplasms.

TREATMENT

Patients with two or more ounces of residual urine usually require removal of their prostatic lesion. The only relief of benign prostatism is by some form of surgery.

Preoperative Requirements

1. Preoperative drainage of the chronically distended bladder by urethral catheterization to relieve back pressure may lead to structural repair of the hydronephrosis. In addition it may increase renal reserve and cause general improvement. Careful decompression, as mentioned before, is very necessary here. Patients with little residual urine usually do not require preoperative drainage.

2. *Kidney Function Tests*: these are a guide to the preoperative state of the patient. Such tests as blood urea and NPN determinations are usually done.

3. *Cardiovascular Appraisal*: most of these patients are of geriatric age, and many cannot stand the strain of an operation without adequate preoperative precautions.

Surgical Approach

Four methods are recognized:

1. *One-Stage Suprapubic Prostatectomy*: This open bladder technique is the quickest and simplest procedure, requiring few specialized instruments, and is safest for the non-specialized surgeon. Median bar tumors can be removed this way as well as co-existing bladder pathology—calculi, tumors, diverticula. Its disadvantage is that it is an extraperitoneal and transvesical procedure.

2. *Retropubic Prostatectomy*: This is the most recent approach devised, and is more difficult than the suprapubic approach. It is suitable for large encapsulated prostates, and those located high up in the perivesical space. It is not recommended if co-existing bladder pathology is present as direct visualization of the bladder cavity is more difficult. It is sometimes used for prostatic malignancy. It gives better results with a lower morbidity and earlier ambulation than the suprapubic approach mainly because the bladder is not opened. Postoperative symptoms are less severe although operative hemorrhage may be marked.

3. *Perineal Prostatectomy*: This method permits complete removal of hypertrophied tissue under direct visualization, and is attended by dependent drainage. It is suitable for a large gland low in the pelvis. Its biggest advantage is that lesions suspected of malignancy can be exposed and biopsied immediately by frozen section. It is a technically more difficult operation than the previous types, and the incidence of incontinence of urine is higher. Injury to the rectal wall with resulting prolapse is not unknown.

4. *Transurethral Resection*: This is

currently the most popular operation, and is particularly suitable for the geriatric patient who tolerates open incisions poorly. It is the operation of choice in advanced carcinoma, contracture of the vesical neck, median bar and hypertrophy of moderate size. Contraindications include urethras of small calibre, bladders with reduced capacity, and very large glands.

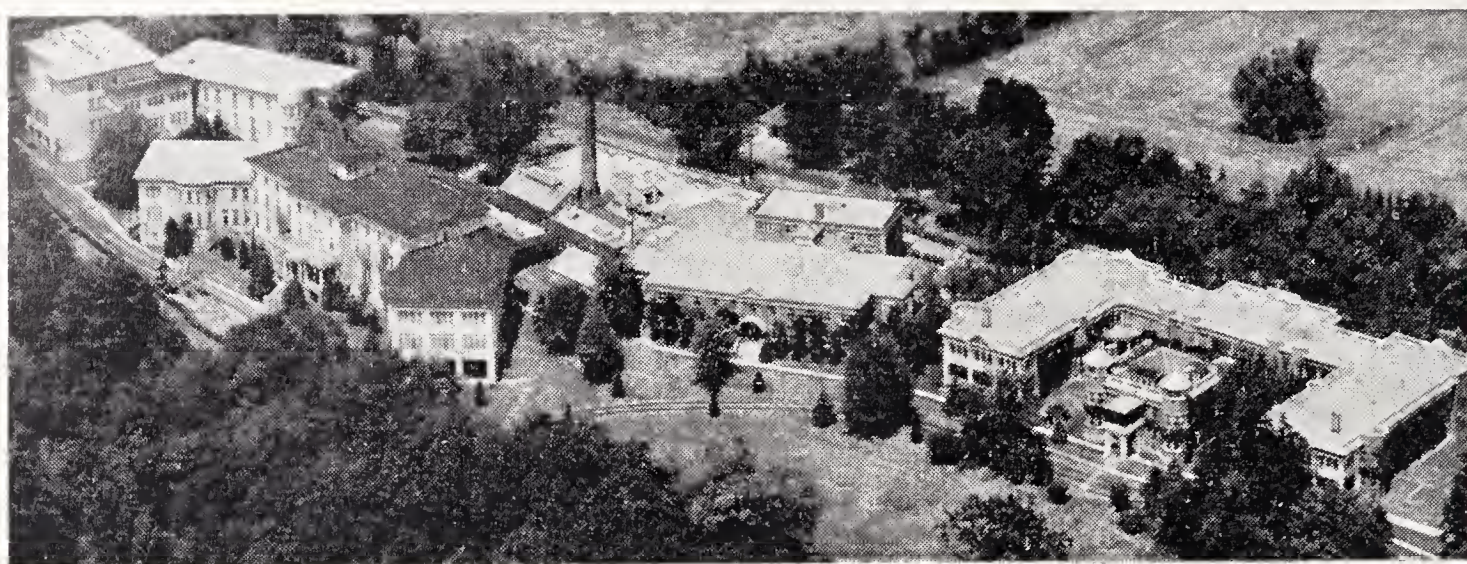
Early postoperative ambulation is seen here, but hemorrhage from penetration of the prostatic capsule or incontinence due to external sphincter injury are often seen in the hands of inexperienced operators. Postoperative contracture of bladder neck and cystitis from incomplete removal of all the hypertrophied tissue can result.

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BIBLIOGRAPHY

1. MacDonald, W. J.: Hypertrophy of the Prostate, 1913.
2. Moullin, C. W. M.: Enlargement of the Prostate, 1904.
3. Ciba Clinical Symposia, Vol. 7, No. 4, Dec., 1955.
4. Nesbit and Baum: Fundamentals of Urology, 1953.
5. Moseley, H. F.: Textbook of Surgery, 1955.



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G.P. OR NOT G.P.?

George Mallory was a mountaineer. He climbed some of the most bitter and frustrating peaks in the world. In 1927, he was beaten by a mountain. In the Spring of that year, members of his expedition saw Mallory and his partner Irvine disappear into the frothy mists of 27,000 feet on Mt. Everest—never to be seen again.

Prior to his disappearance, he was asked why he climbed mountains—a pastime that is contrary to logic.

Significantly he answered: Because It Is There.

Logic insists that you specialize.

It points out that the money is better.

It righteously affirms that the prestige is greater.

It tellingly states that the hours are more convenient.

Hardly anything recommends General Practise—particularly in the out-regions.

The only piece of logic that can be brought to its defence is lamentably pedestrian. Simply put, it says: "General Practitioners are urgently needed today".

Yet beyond logic—where man is not so concerned with his position among people but with his purpose toward humanity—lies The Challenge. The Challenge is as vague, as undefined and elusive yet as enticing as the challenge Mallory faced. It is a challenge meant to be accepted by only dedicated men. And like Mallory, the reason for accepting the challenge is almost completely hidden from logic—the challenge of General Practise defies logic because it is so important—and one can only say anti-climatically:

"Because It Is There".



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